Small Business Innovation Research/Small Business Tech Transfer

Humidity Monitor for In-Situ Resource Reutilization on Mars, Phase I

Completed Technology Project (2018 - 2019)

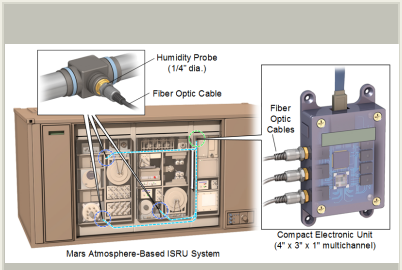
Project Introduction

As human exploration moves deeper into space, it becomes critical to acquire supplies from the environment in-situ. NASA has identified oxygen, water, and methane as the most critical assets that could be acquired by means of in-situ resource utilization (ISRU). Given that the Martian atmosphere is 95.9% CO_2, atmospheric processing is the most feasible ISRU method of producing O_2, H_2O, and CH_4. The MOXIE experiment is underway to demonstrate in-situ production of O_2 for propellant and for breathing on Mars (Mars 2020 Rover). The gas produced by ISRU CO_2 processing needs to be "completely dry" for cryogenic liquefaction, as traces of residual water can impede the efficiency of cryogenic storage and combustion, but commercial technologies for monitoring traces of water in "dry" gases are too bulky and complex for use in space or on Mars. ***Intelligent Optical Systems (IOS) will develop a compact humidity monitor to detect low ppmv of water in oxygen and methane,*** designed to meet the requirements for space exploration and operation in combustible environments. The proposed monitor will incorporate a novel luminescent sensor element, which consists of a luminescent indicator dye highly sensitive to water vapor, immobilized in a polymer support. The optical technique is time-based, which gives it excellent reliability and accuracy, and avoids the drawbacks of intensity-based measurements. IOS has developed and delivered humidity sensors for NASA space suit development programs, demonstrating operation in oxygen, nitrogen, and other gases, and has demonstrated that it can monitor low ppm of water. In Phase I, we will demonstrate a novel sensitive element for detecting low ppm of water, focusing on sensitivity, measurement range, and minimal or no maintenance on long term missions. In Phase II, IOS will develop the complete monitoring system, which could also accommodate sensors for other gases of interest in ISRU units (O_2, CO_2…).

Anticipated Benefits

The most direct application for the proposed sensor would be humidity monitoring in ISRU systems for the Mars atmosphere. We anticipate initial infusion of this technology in ground demonstrators, and later in small scale ISRU systems such as the MOXIE experiment. The technology's suitability for miniaturization and multiplexing, and its capability of incorporating additional sensors will open opportunities for application in any Mars Atmosphere-Based or Regolith-Based ISRU program.

The humidity monitoring market can be divided into low ppm moisture monitoring applications (in the gas and petrochemical industries) and ambient relative humidity monitoring. We are already developing a low cost device for ambient humidity monitoring, adapting sensor elements initially developed for monitoring humidity in spacesuits. Transition of our technology to the low ppm moisture monitoring market will follow, and the proposed project represents



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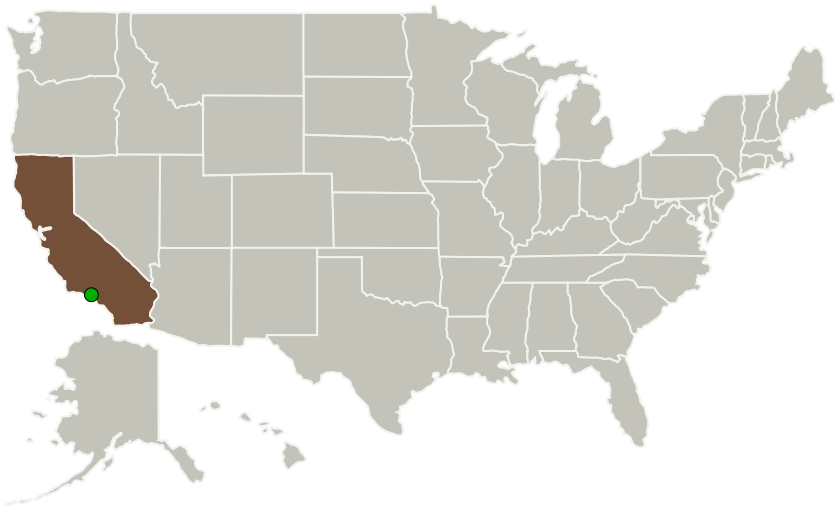
an excellent opportunity in that direction.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Intelligent Optical Systems, Inc.	Lead Organization	Industry	Torrance, California
Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations
California

Project Transitions

July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141370)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Intelligent Optical Systems, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

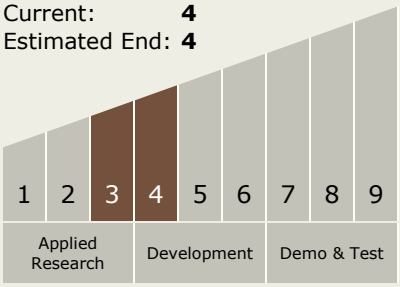
Carlos Torrez

Principal Investigator:

Jesus D Alonso

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



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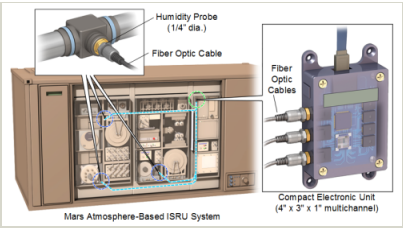
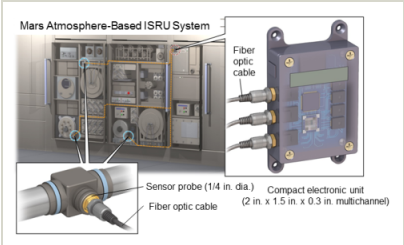
Images



Briefing Chart Image
Humidity Monitor for In-Situ Resource Reutilization on Mars, Phase I
(https://techport.nasa.gov/image/132386)



Final Summary Chart Image
Humidity Monitor for In-Situ Resource Reutilization on Mars, Phase I
(https://techport.nasa.gov/image/136686)

Technology Areas

Primary:

- TX07 Exploration Destination Systems
  - TX07.1 In-Situ Resource Utilization
    - TX07.1.3 Resource Processing for Production of Mission Consumables

Target Destination

Mars